EUROPEAN
CLIMATE CHANGE
ADAPTATION CONFERENCE 2013

Hamburg, March 18, 2013

Analyzing adaptation to climate change in the water and the agricultural sectors in the Spanish Guadiana basin

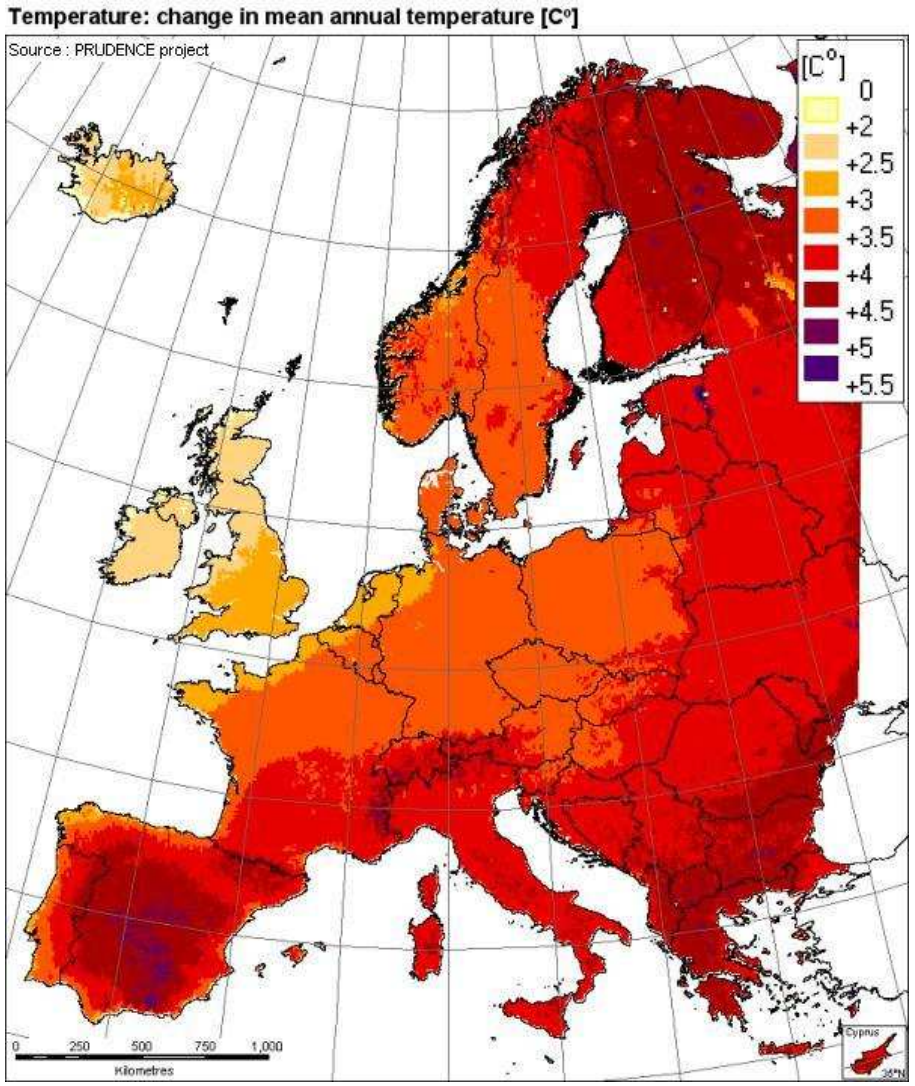
Consuelo Varela-Ortega, Irene Blanco, Paloma Esteve, Sukaina Bharwani, Thomas E. Downing, Eduardo Juárez

UPM (Universidad Politécnica de Madrid), Spain
SEI (Stockholm Environment Institute), UK

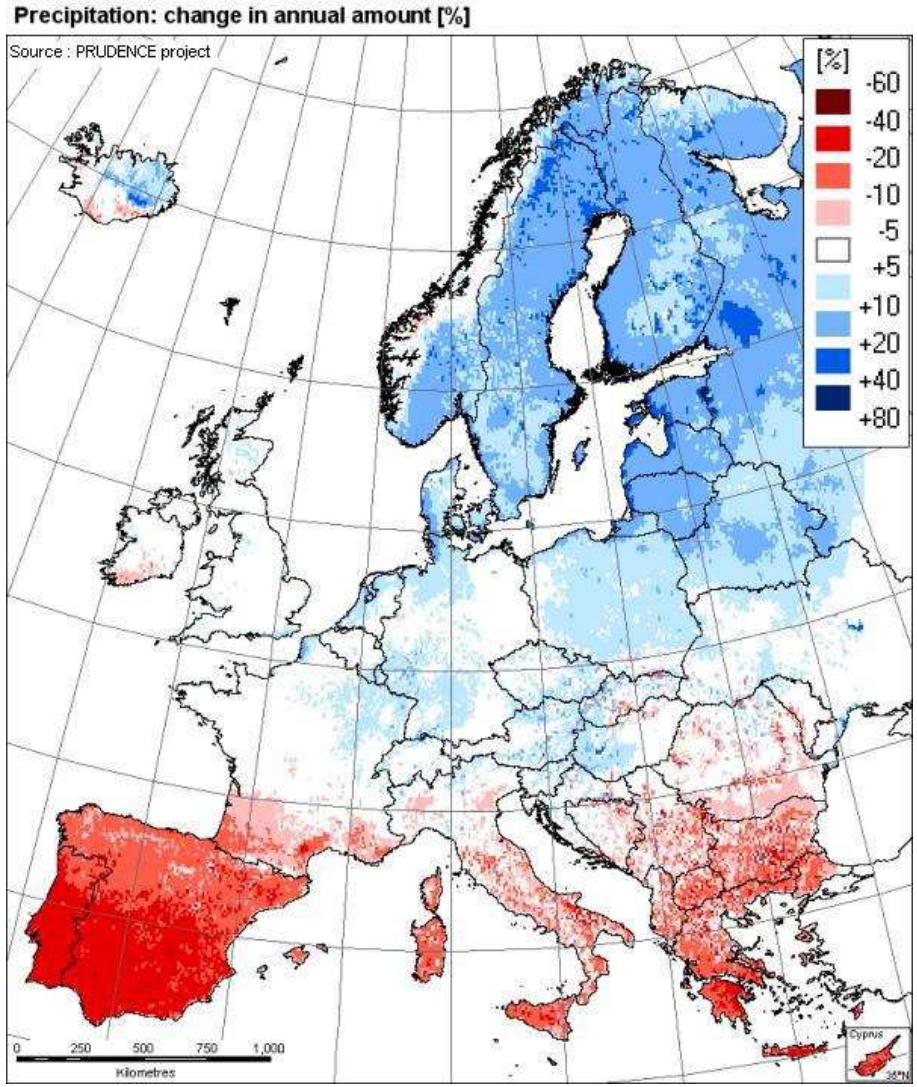
Contents

1. Introduction: setting and problem definition

Map 1. Change in mean annual temperature by the end of this century



Map 2. Change in mean annual precipitation by the end of this century

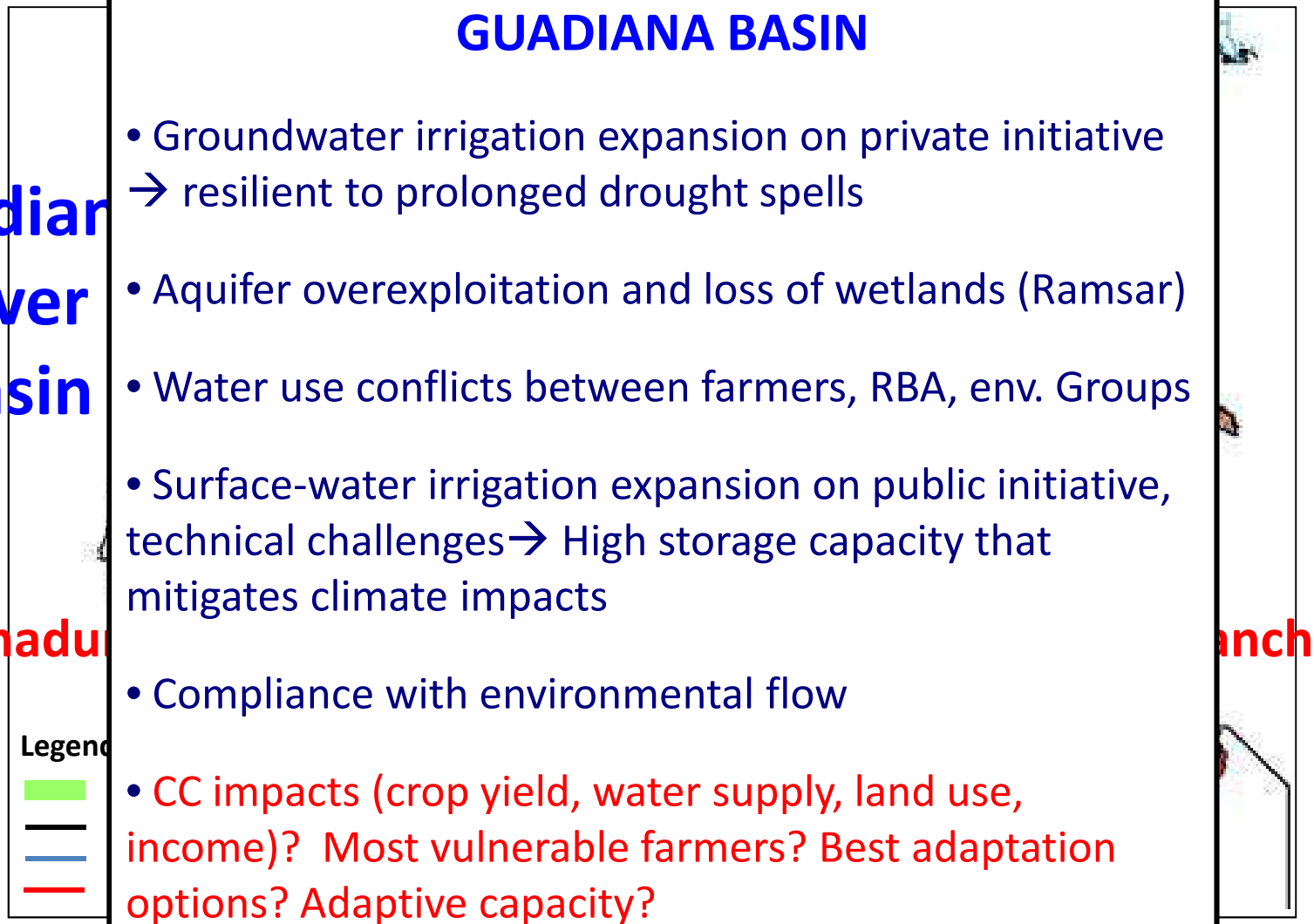


IPCC scenario A2 (1961-1990 --- 2071-2100) EU Green paper on adpatation to CC (2007)

1. Introduction: setting and problem definition

MEDIATION Case studies: Southern Europe

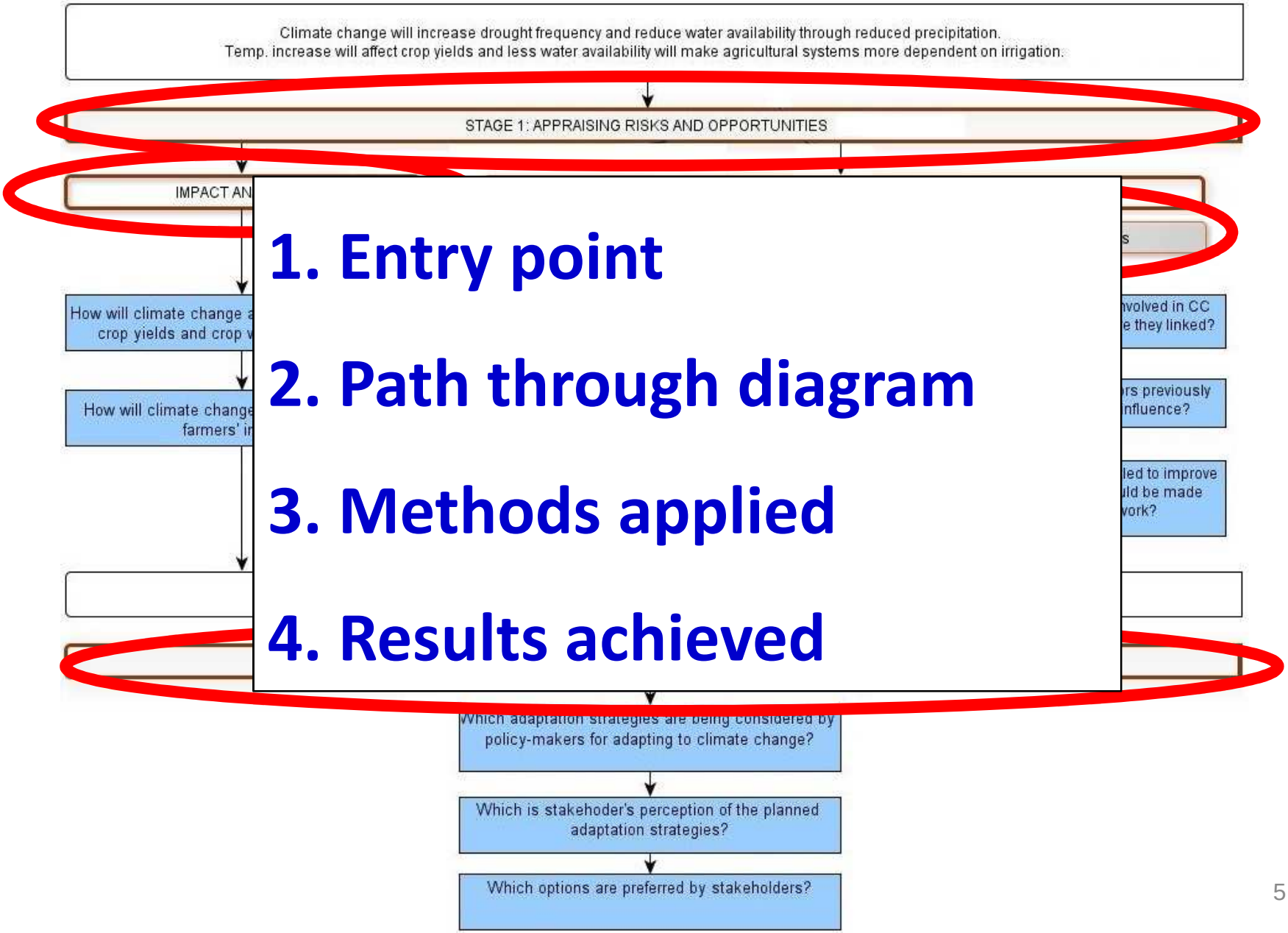
The Guadiana Basin in Spain



GUADIANA BASIN

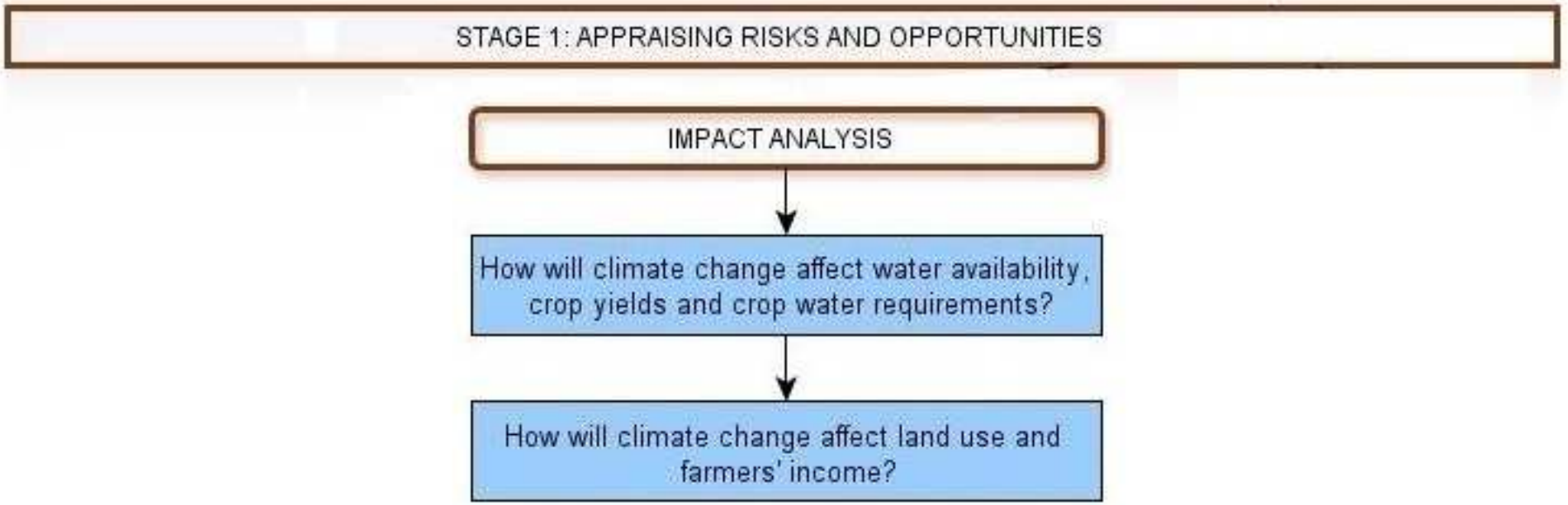
- Groundwater irrigation expansion on private initiative → resilient to prolonged drought spells
- Aquifer overexploitation and loss of wetlands (Ramsar)
- Water use conflicts between farmers, RBA, env. Groups
- Surface-water irrigation expansion on public initiative, technical challenges→ High storage capacity that mitigates climate impacts
- Compliance with environmental flow
- CC impacts (crop yield, water supply, land use, income)? Most vulnerable farmers? Best adaptation options? Adaptive capacity?

2. The Adaptation Pathway



2.1 Step 1: Impact analysis (Stage 1)

Entry point
Path through diagram



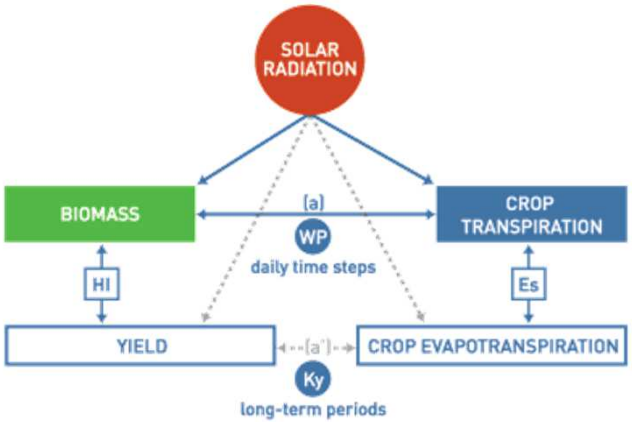
2.1 Step 1: Impact analysis (Stage 1)

Methods applied

Knowledge base

Field work, statistical analysis, SH analysis, GIS processing, literature

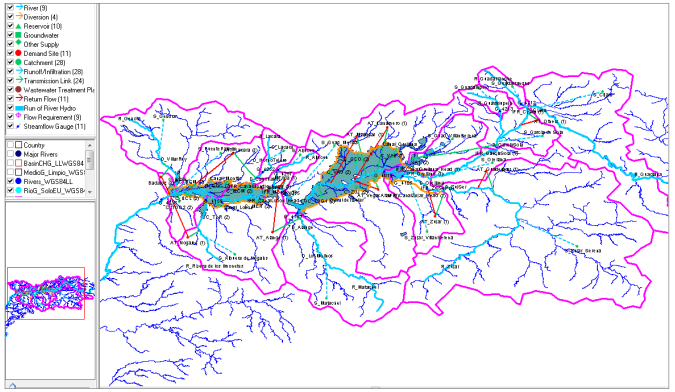
Agronomic model (AquaCrop) → **Economic model (MPM)** ⇄ **Integration** ⇄ **Hydrologic model (WEAP-MABIA)**



$$Max_x\ U = Z(x) - R(x)$$

$$Subject\ \ to:\ \ Ax \le b$$

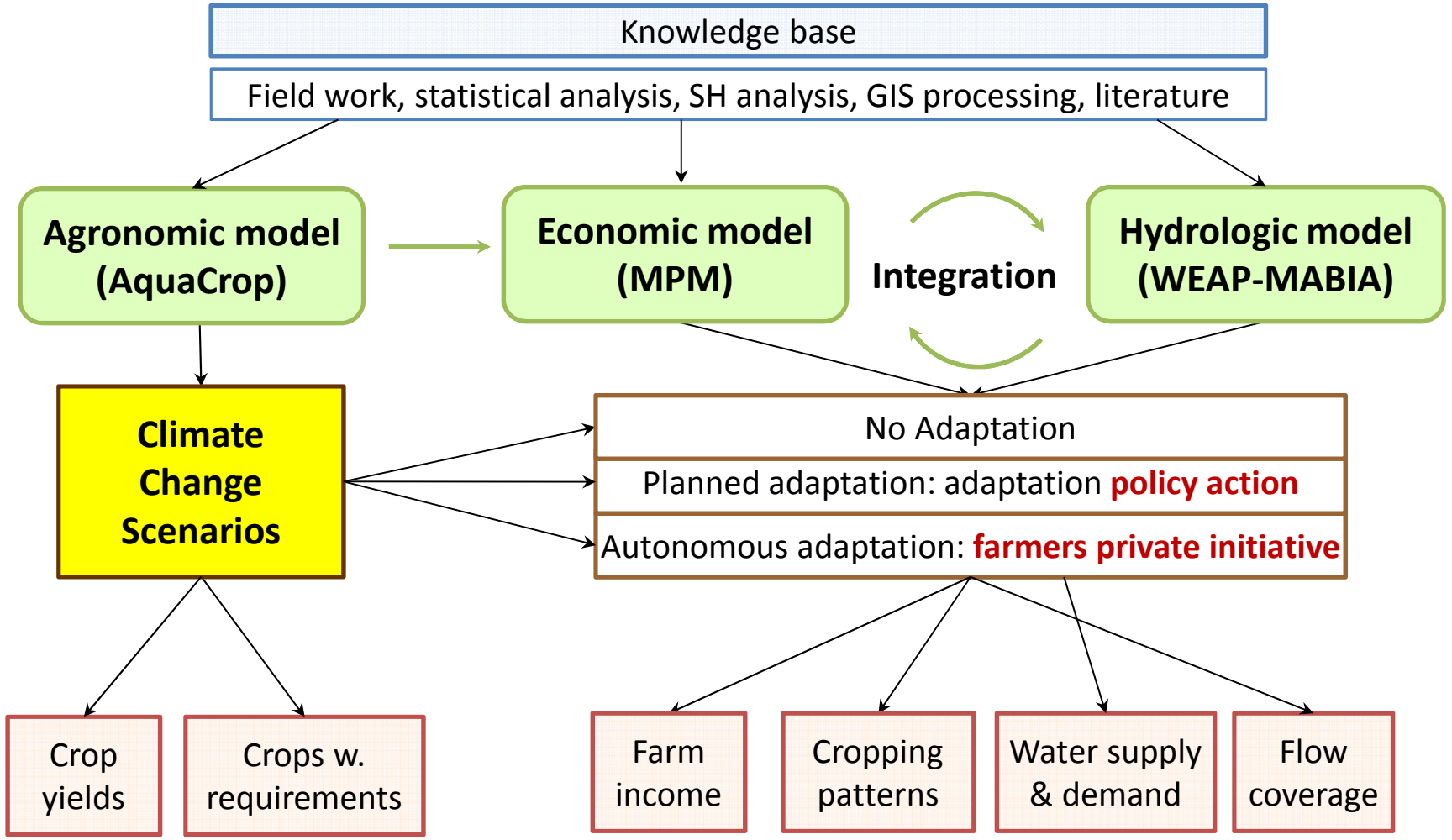
$$x \ge 0$$



Plot level *Farm scale* *River Basin scale*

2.1 Step 1: Impact analysis (Stage 1)

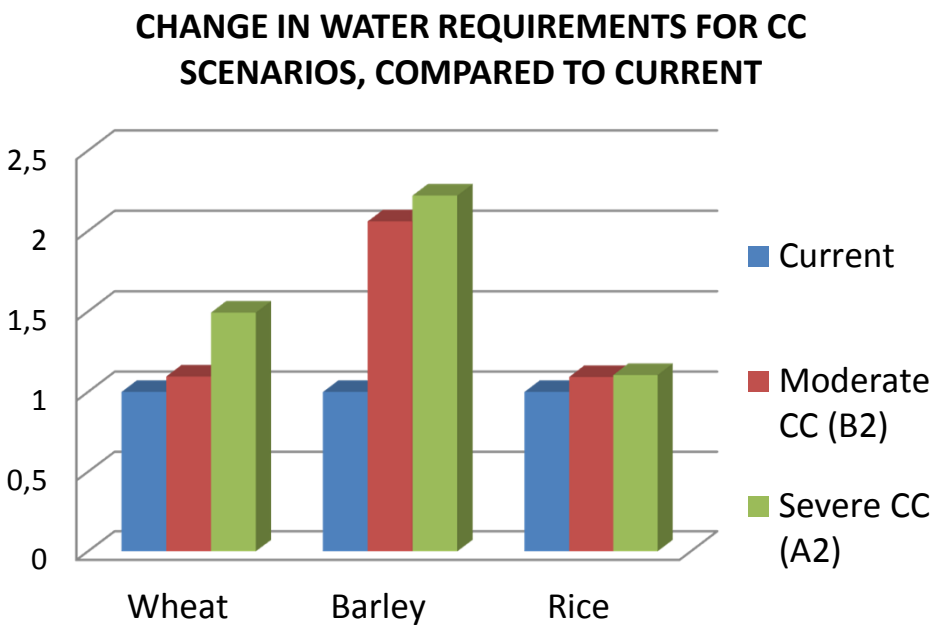
Methods applied

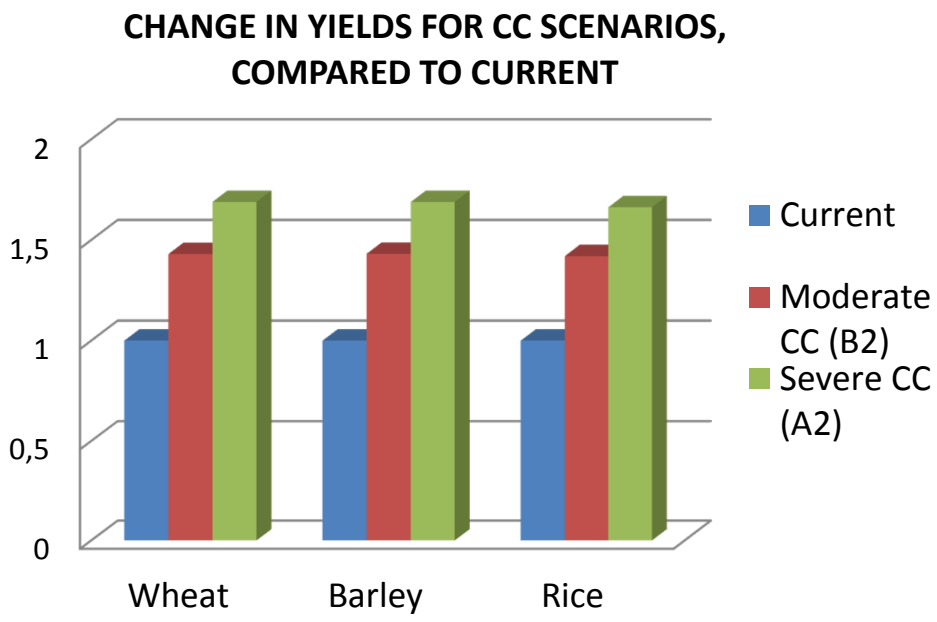


2.1 Step 1: Impact analysis (Stage 1)

Results achieved

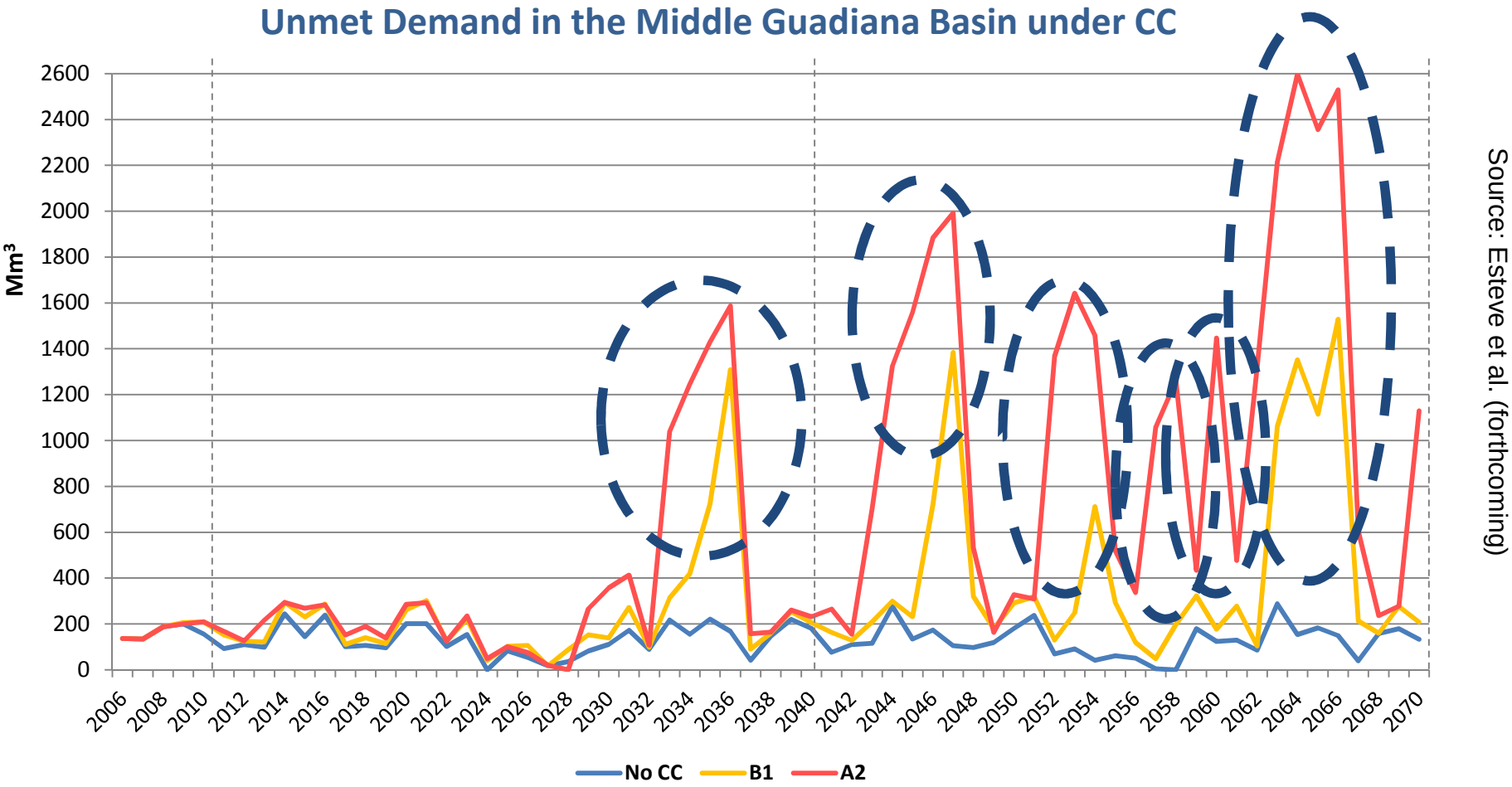
Crop model: simulation of CC scenarios





2.1 Step 1: Impact analysis (Stage 1)

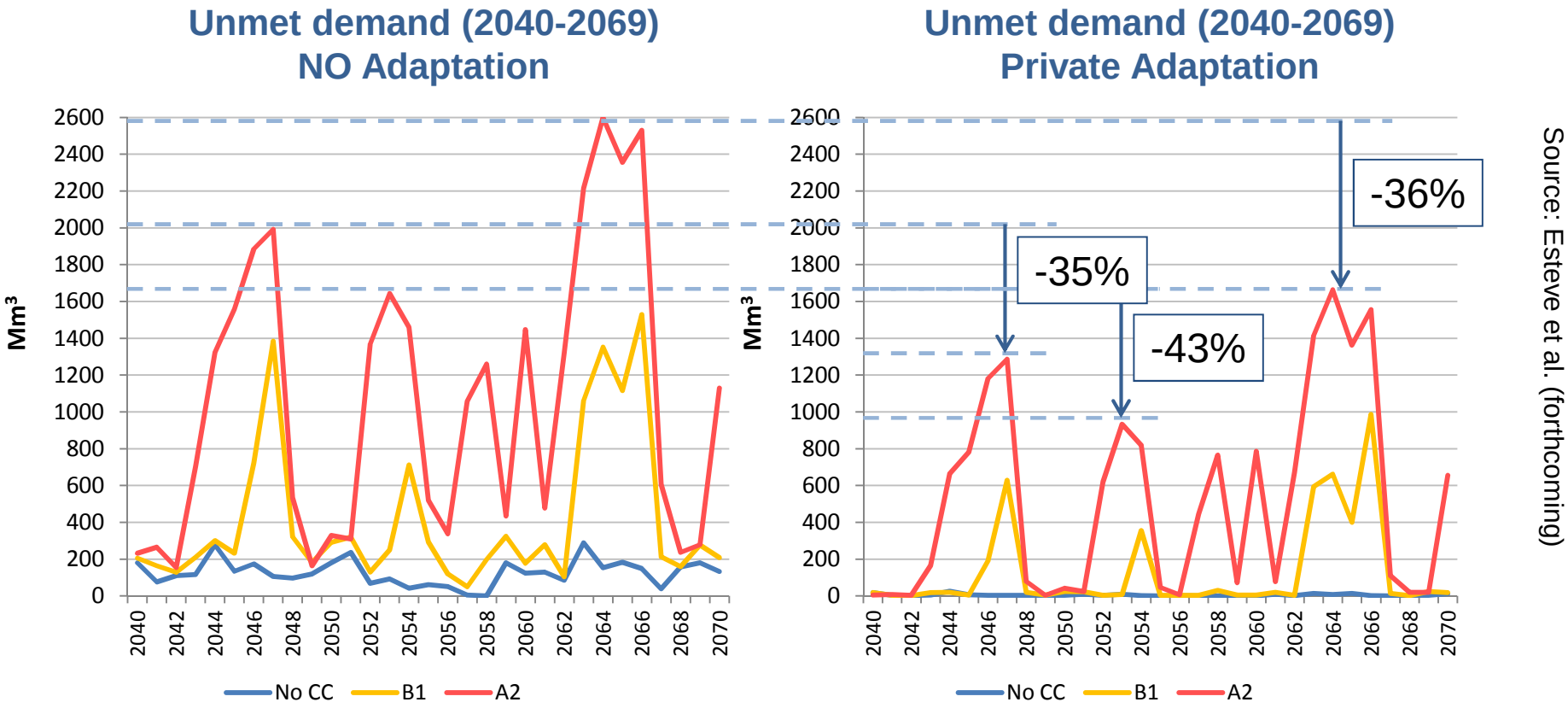
Results achieved



Source: Esteve et al. (forthcoming)

2.1 Step 1: Impact analysis (Stage 1)

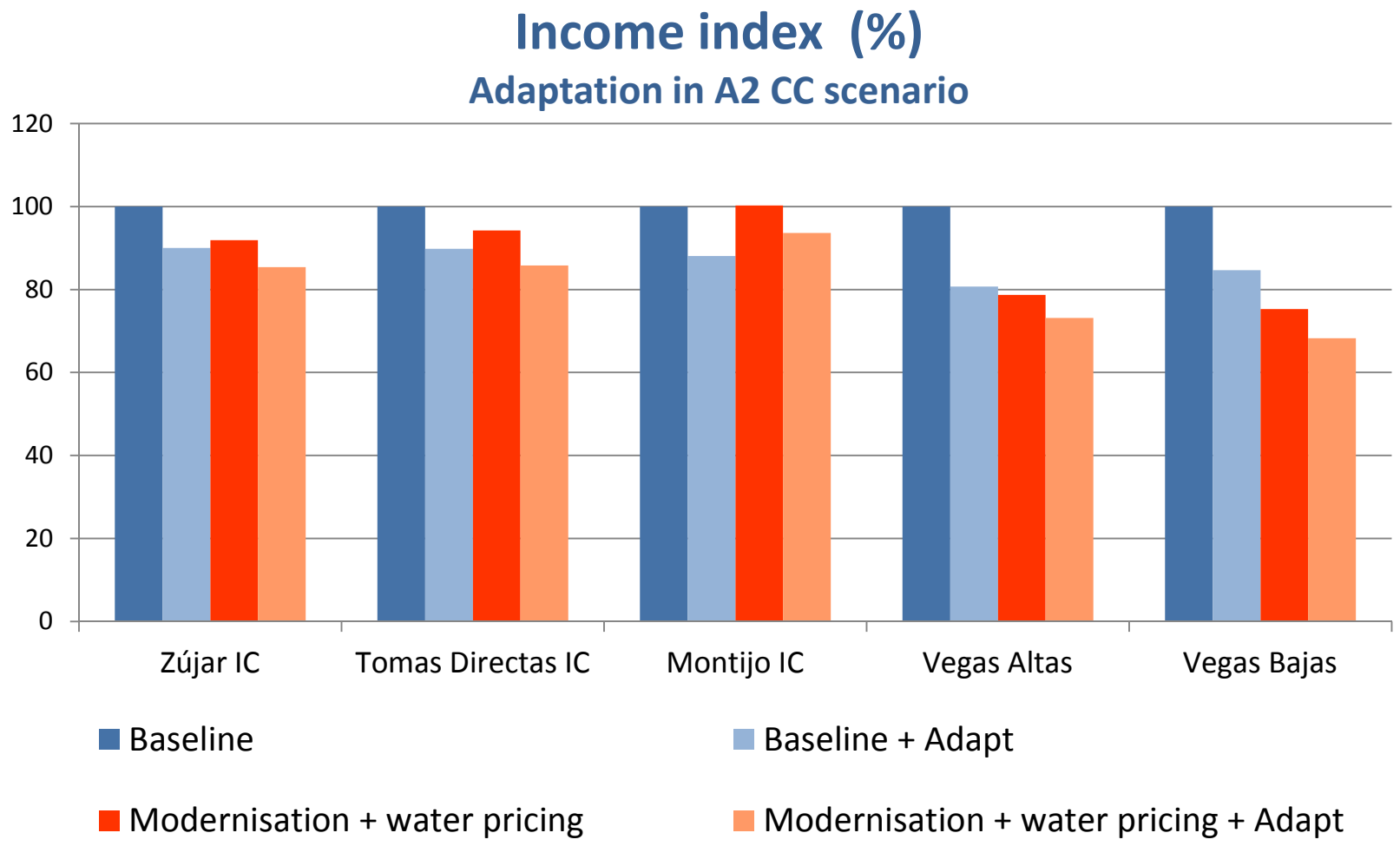
Results achieved



Source: Esteve et al. (forthcoming)

2.1 Step 1: Impact analysis (Stage 1)

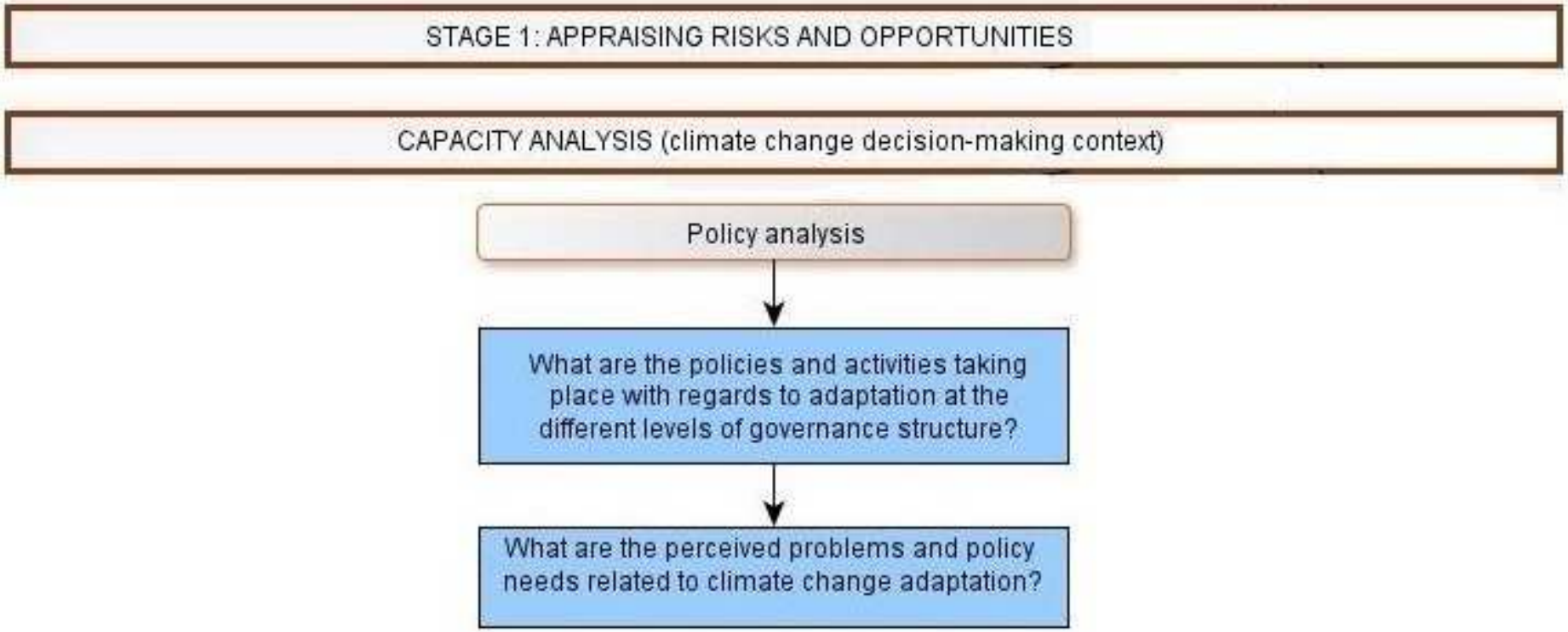
Results achieved



Source: Esteve et al. (forthcoming)

2.1 Step 2: Policy analysis (Stage 1)

Entry point
Path through diagram



2.1 Step 2: Policy analysis (Stage 1)

Methods applied

- Semi-structured guided interviews, institutional mapping and literature review.
- Interviews to CC policy-makers and sectoral policy-makers (water, agriculture) (May 2010- Feb 2011)
  - 2 workshops for tool development
  - General MEDIATION SH meeting (June 2011)

Sector	SH Group	Scale
Climate change	Policy makers	Regional
Water	Policy makers, users (ICs)	River basin, regional, local
Agriculture	Policy makers, farmers	Regional, local
Environment	Env. groups	National, regional

2.1 Step 2: Policy analysis (Stage 1)

Results achieved

- Climate change adaptation policies and measures in Spain are still at an **incipient phase**
- Each **regional government** is developing strategies that respond to the particular needs
- The **primary needs** to develop adaptation plans in Spain focus on 5 areas:

1. Information needs

- Lack of solid scientific basis for policy decision making on adaptation
- More information at a smaller regional/local scale is necessary
- Need to improve science/policy interactions

2. Inter-administrative and scientific coordination and collaboration

- Build effective platforms to exchange experiences and knowledge

3. Public participation and social involvement in climate change policies and measures

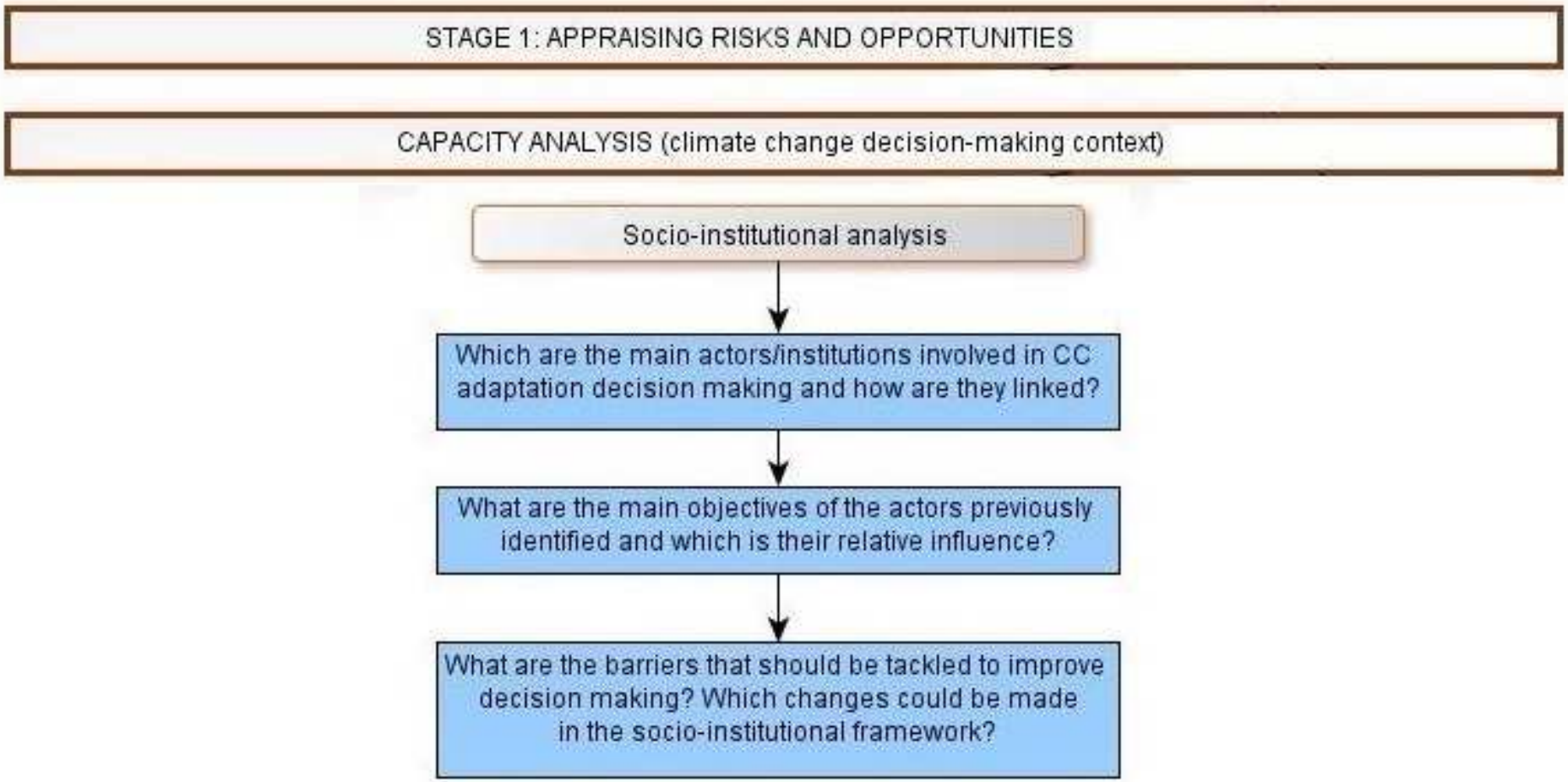
- Incorporate stakeholders and the in debates over climate change strategies and plans

4. Funding

5. Enforcement mechanisms

2.1 Step 3: Socio-institutional analysis (Stage 1)

Entry point
Path through diagram



2.1 Step 3: Socio-institutional analysis (Stage 1)

Methods applied

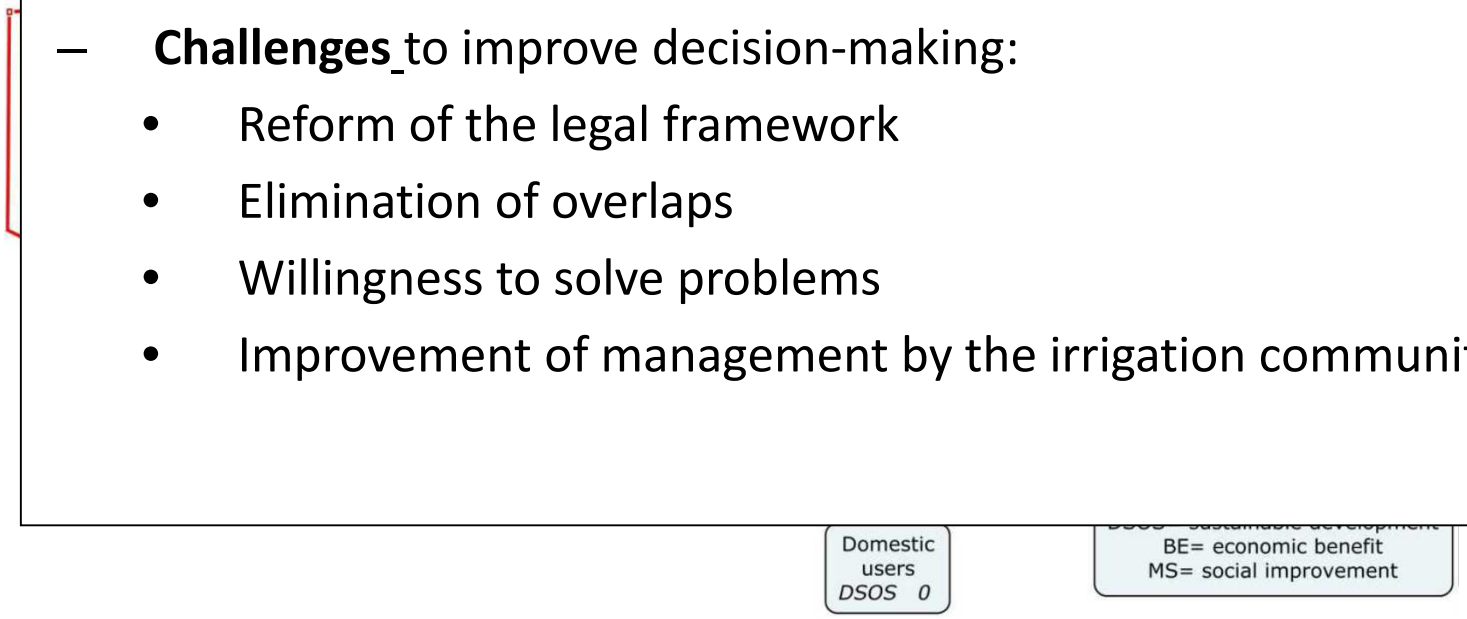
- Socio-institutional Network Mapping (SNM) using the NetMap approach in a Stakeholder workshop
- 15 Stakeholders of 3 institutional groups:
  - Water administration
  - Farmers (from irrigation communities)
  - Environmental NGOs and CC officers (national & regional Admin.)
- SNM built by each group showing actors' interrelations on:
  - Information flow
  - Financial flow
  - Implementation capacity

2.1 Step 3: Socio-institutional analysis (Stage 1)

Results achieved

Water Administration

- **Clustered Network** with high number of links
- **Information flow** : central role of Administrations
- **Financial flow** : EU → scientific community →administration
- **Implementation flow**: EU → users and central Adm → autonomous Adm → local Adm
- **Challenges** to improve decision-making:
  - Reform of the legal framework
  - Elimination of overlaps
  - Willingness to solve problems
  - Improvement of management by the irrigation communities



2.1 Step 3: Socio-institutional analysis (Stage 1)

Results achieved

Farmers

- **Dispersed network** with a lower number of links and actors
- **Information flow:** UNFCC → EU → central government → autonomous regions → farmers
- **Financial flow:** EU → scientific community → central government → autonomous regions→ farmers
- **Implementation flow :** All Admin. → irrigation communities
- **Challenges** to improve decision-making :
  - Increase in trust
  - Take advantage of synergies between RBA and regional Dep. Agric.
  - Increase links of Rain-fed agriculture and environmental NGOs
  - Strengthen connections of academics and farmers
  - Empower Irrigation communities (capacity for action, funding, decision making…)

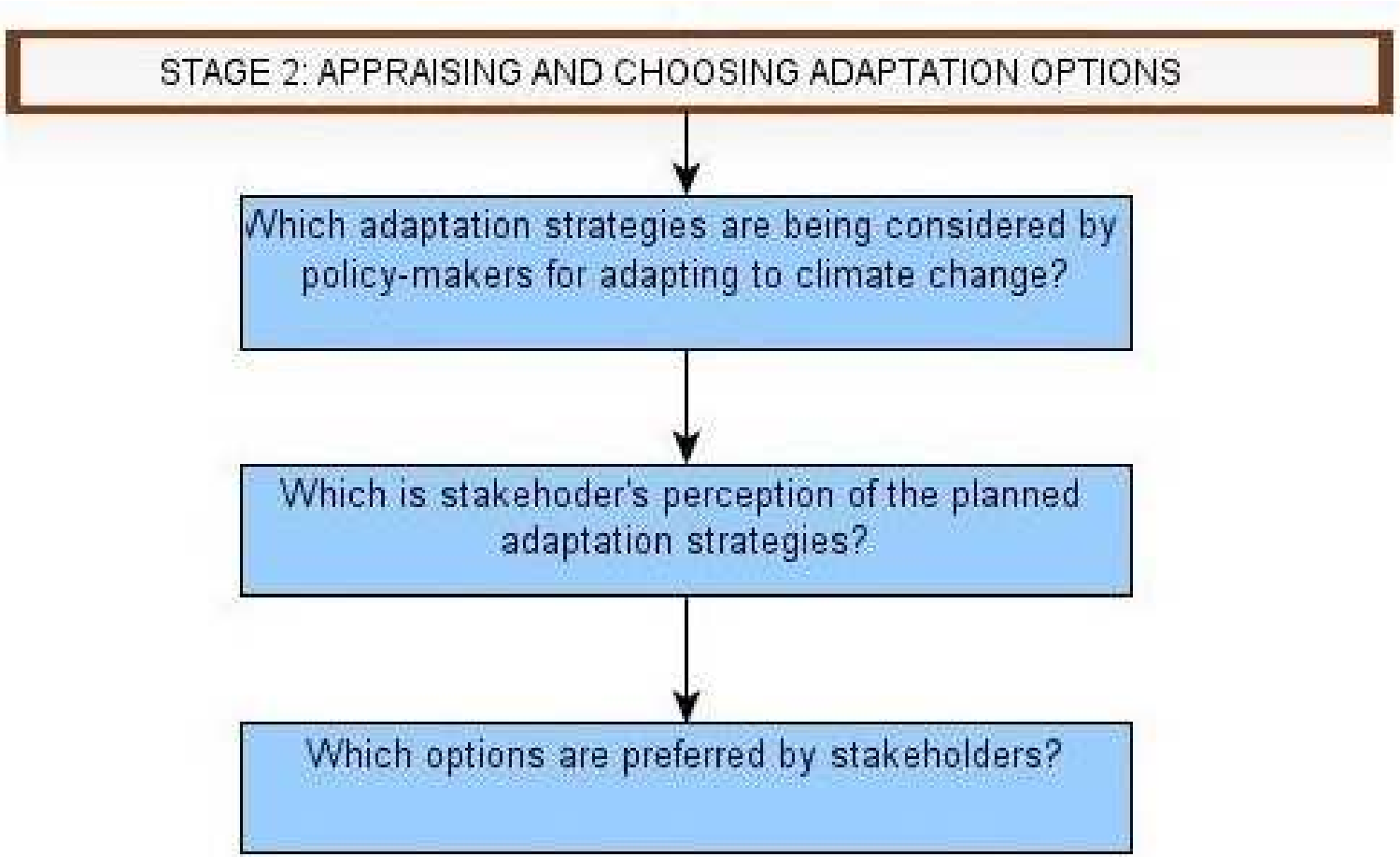
2.1 Step 3: Socio-institutional analysis (Stage 1)

Results achieved

Environmental actors

- **Balanced network**, no evident clusters, high number of links
- **Financial flow:** EU → tourism sector ; SpOffCC → AgrProdOrg
- **Information flow:** EU → all
- **Implementation flow:** AgrProdOrg → farmers
- There many connections to the *EU*, which makes the system very much dependent on this actor alone
- **Challenges** to improve decision-making :
  - Facilitate synergies by developing tools and strategies for raising awareness on CC
  - Involve the media

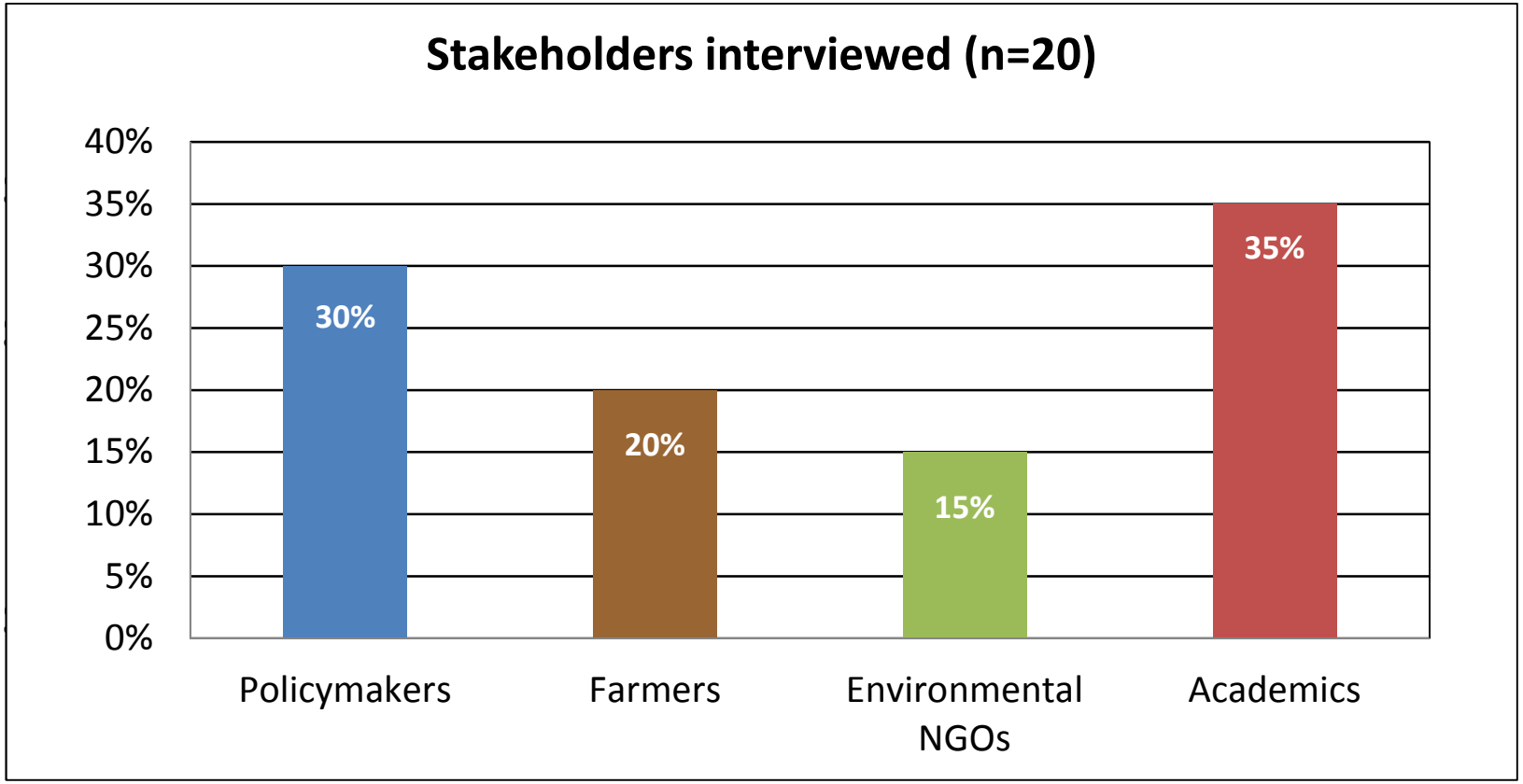
Entry point
Path through diagram



2.2 Step 4: Appraising and choosing adaptation options (Stage 2)

Methods applied: Analytical Hierarchical Process (AHP)

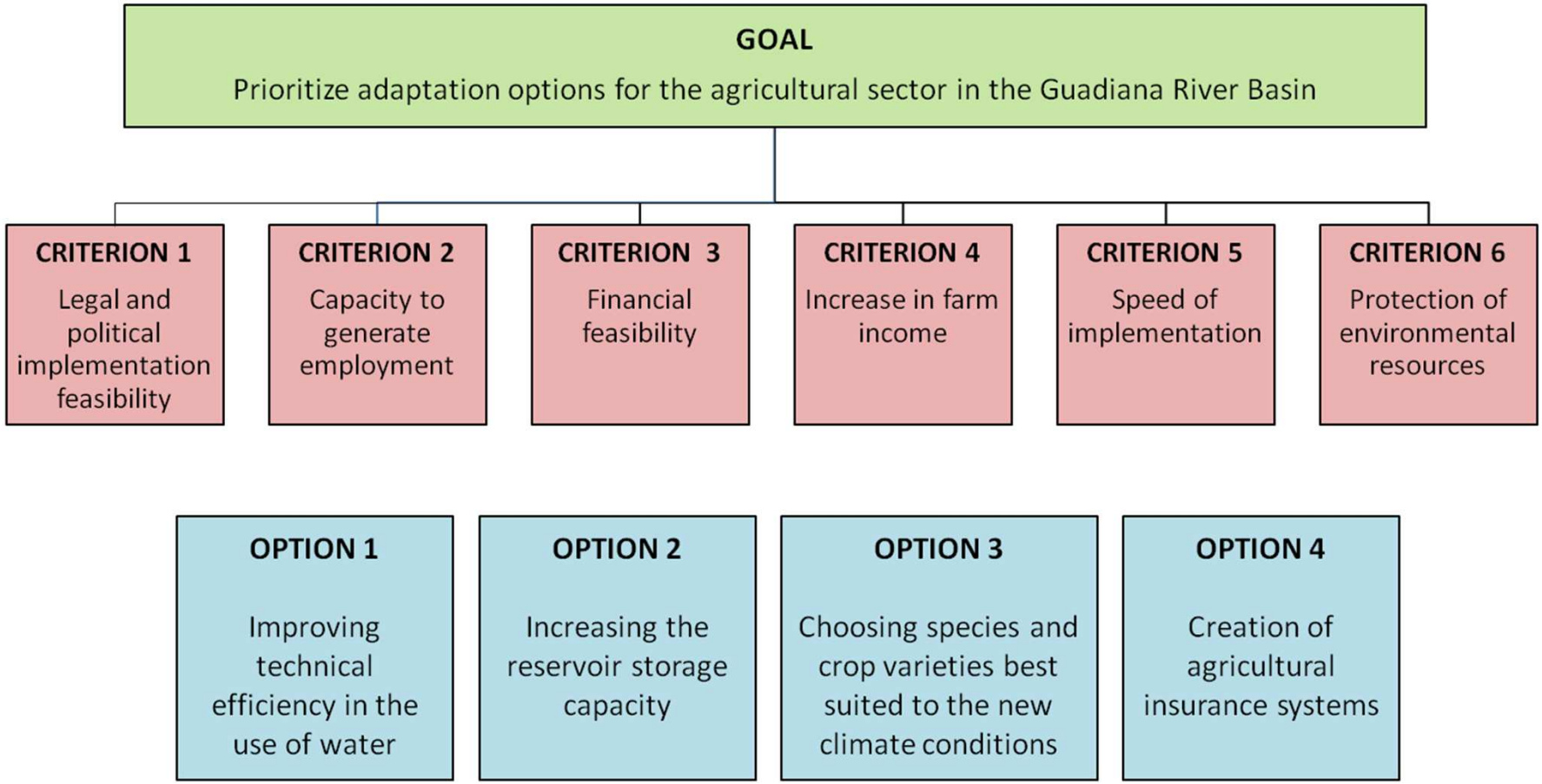
- **Step 1: Define**



- **Step 5**
  - Aggregate relative priorities to produce overall priorities

2.2 Step 4: Appraising and choosing adaptation options (Stage 2)

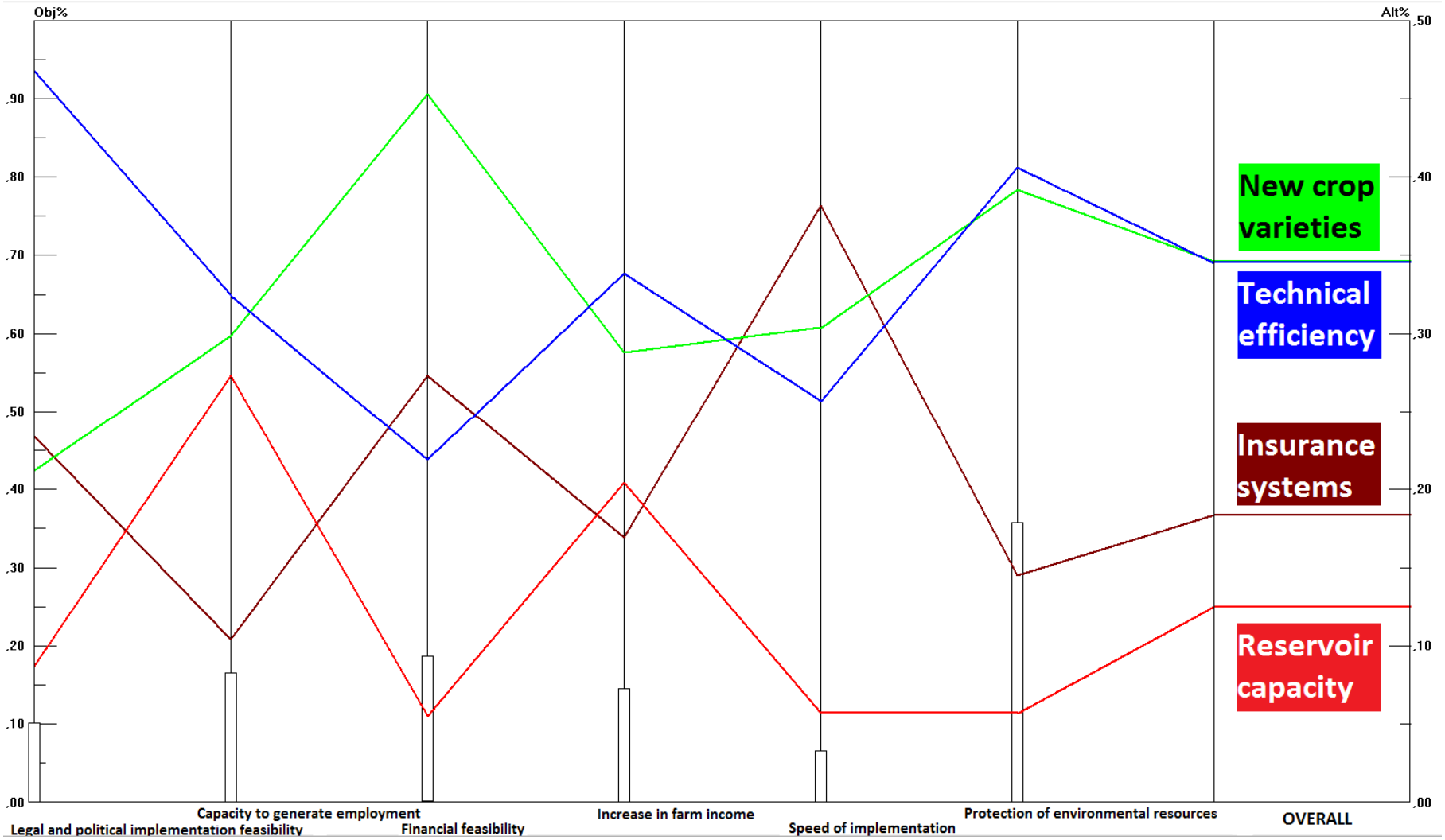
Methods applied



2.2 Step 4: Appraising and choosing adaptation options (Stage 2)

Results achieved

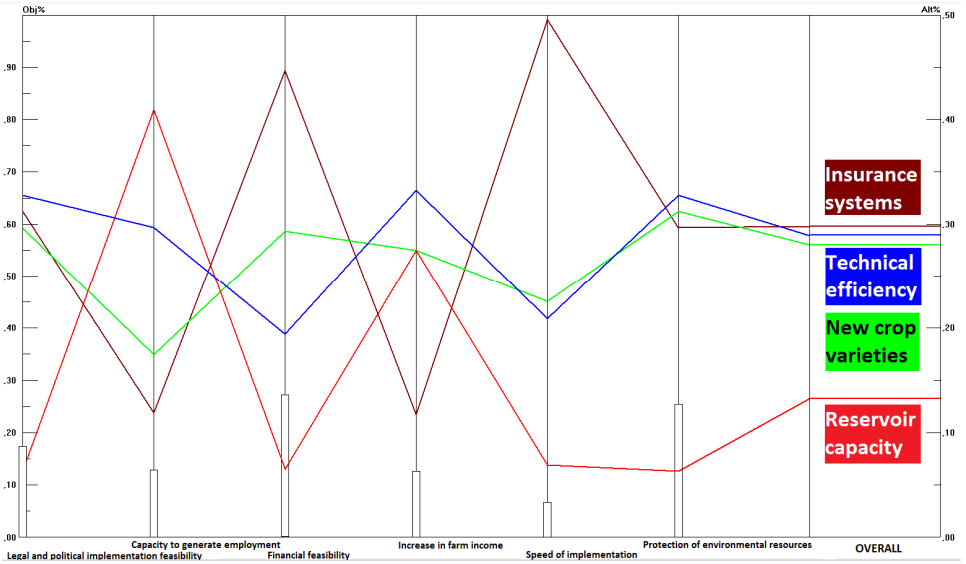
Aggregate results



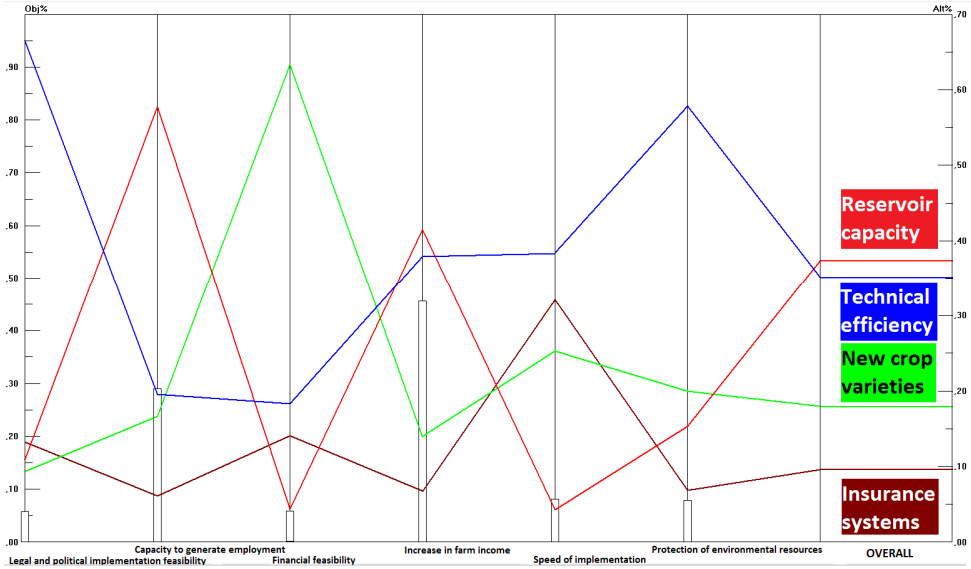
2.2 Step 4: Appraising and choosing adaptation options (Stage 2)

Results

Policymakers



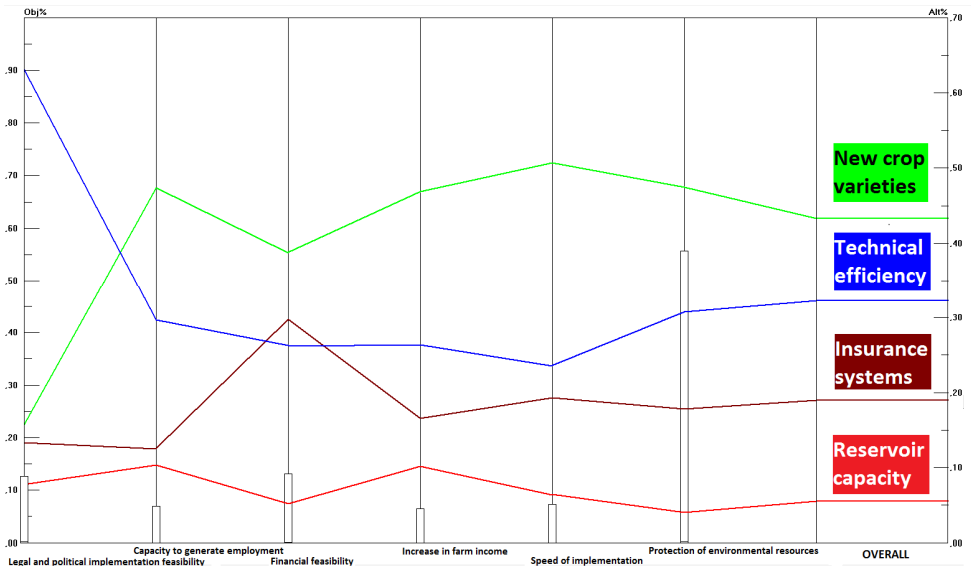
Farmers



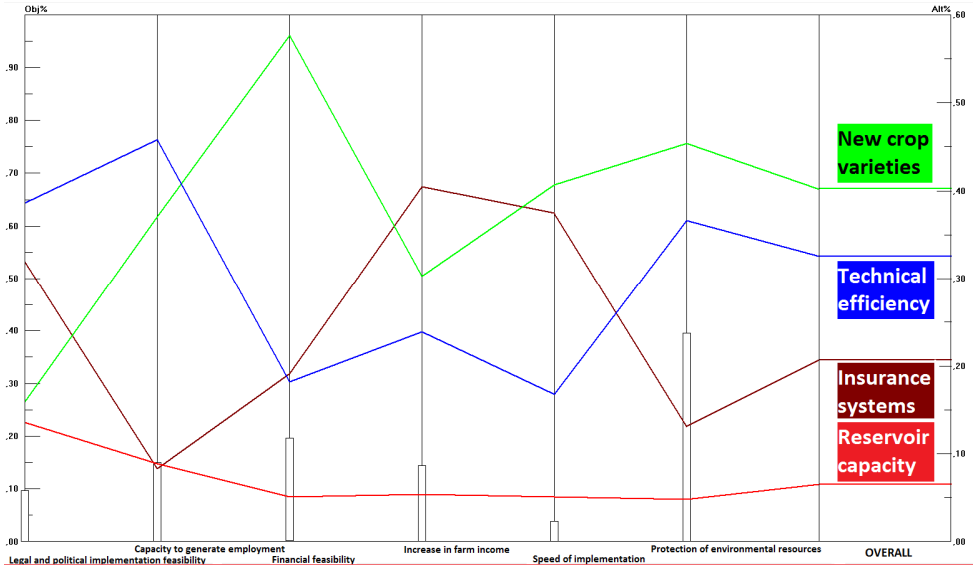
2.2 Step 4: Appraising and choosing adaptation options (Stage 2)

Results

Environmental NGOs



Academics



Conclusions

- **On the method: CCA decision-making pathway**
  - Flows from a **science-driven** question to the **needs of policy-makers** for designing, implementing and selecting CCA options
  - Permits a **structured analysis** of decision-making pathway involving risks and opportunities
  - Tree structure provides evidence of the **methods' strengths and weaknesses**, **balanced integration** of models:
    - ✓ Starting with a qualitative mapping of decision units → quantitative assessment (models) → SH-based actors' networks → SH-based semi-quantitative models for prioritizing CCA options

Conclusions

On the results:

- **Integrated modeling for CC impact analysis**
  - Rising temperatures will translate into **increased crop w. requirements.** More CO_2 could increase **yields** at all temperature rise provided water will be available
  - Agriculture may experience a high level of **unmet demand** from 2040-2070 under severe CC. **Implementing adap. strategies** could reduce by 30-40% unmet irrigation demands. However, ensuring water availability for crop production means **sacrificing farm income** on average
- **SH-based institutional analysis (SNM):**
  - SNM shows that CCA **actors –flows are perceived differently** across SH groups
    - Central and regional Administration → top-down vision, need of mediators
    - Farmers → local and individual vision, need of mediators
    - Environmental NGOs → holistic vision , deepest understanding of the CCA process
  - All SHs agree that **most influential actors** are: EU > National Adm.> Regional Adm. > Farmers

Conclusions

On the results:

- **SH-based institutional analysis (AHP):**
  - AHP **aggregate results** show that, in average,
    - Environmental **criteria** are preferred to social-economic-financial criteria and much more to technical criteria
    - **Options** related to private farming (new crops and irrigation efficiency) are ranked highest, public-funded hard measures (reservoirs) are lowest, public soft measures (insurance) are ranked middle
  - AHP ranking varies across **SH groups**:
    - **Policy makers** prefer soft measures (insurance) and discard large irrigation infrastructures due to severe financial, political and environmental constraints.
    - **Farmers** priorities are technically oriented ranking first the construction of water storage infrastructures to reduce crop failure under CC
    - **Environmental NGOs and Academics** rank CCA options similarly to the average aggregate

Conclusions

- **On policies:**
  - **Policies (WFD, CAP)** can play an essential role in enhancing the ability of agriculture to adapt to climate variability, while protecting and preserving the environment.
  - **CCA measures** provide a way to cushion the adverse effects of climate change. Thus, increasing attention should be paid to integrate CCA into decision-making.
  - Adapting to climate change requires revision of the current **governance structures** and inclusion of **uncertainty** into adaption decision-making.
  - SH-based analysis shows that: Further research has to take into account **barriers** to adopting CCA options, such as lack of common understanding, financial resources, integration of policies, coordination across different administration levels

MUCHAS GRACIAS!

consuelo.varela@upm.es

Source: FAO